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Adaptive management

Had I mixed those damned vials of smoke correctly …

Experimental approaches in threatened plant translocations

Biodiversity and ecologically sensitive grazing: collected extracts from 'Biodiversity in the paddock: a land managers guide'

Down by the riverside: lessons to be learned from low success in revegetating a riparian corridor

Interview: a bush regenerator's perspective

And much more …

SPECIAL THEME: TRIALS AND ERRORS

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Australasian Plant Conservation

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"To promote and improve plant conservation"

Contributing to *Australasian Plant Conservation*

Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. **The deadline for the March–May 2009 issue is Friday 20 February 2009.** The theme of that issue will be 'Germplasm conservation – saving plants for the future'. General articles are also very welcome. Please contact Rosemary Purdie if you are intending to submit an article: Rosemary.Purdie@environment.gov.au.

Authors are encouraged to submit images with articles or information. Please submit images as clear prints, slides, drawings, or in electronic format. Electronic images need to be at least 300 dpi resolution, submitted in at least the size that they are to be published, in tif, jpg or gif format. Guidelines for authors are at: http://www.anpc.asn.au/anpc/pdffiles/APCGuideContrib.pdf.

Please send articles, no more than 1100 words, as a MS Word (2000 compatible) or rich text format file, on disk or by email to: Rosemary.Purdie@environment.gov.au.

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Front cover: (left to right) Planting seedlings; conservation sign; tree guards. Photos: Murray Fagg; Brynley Waters; Rosemary Purdie. (main) Gippsland Plains Grassland remnant, Mulgoa, Vic. Photo: Rosemary Purdie.
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From the Editor

Rosemary Purdie

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How often have you been at a meeting/conference/workshop and heard people talking about the need to communicate when things have 'gone wrong' or not as we expected them to go, so we can learn from our mistakes? ANPC decided to do just this, hence the 'Trials and errors' theme for this issue of *Australasian Plant Conservation* (APC).

Learning and modifying our actions as we go is a fundamental part of adaptive management, yet there's often considerable reticence about publicly 'fessing-up' to mistakes. The 'Trials and errors' papers in this issue draw on a diversity of experiences in plant conservation. They start with an overview of the adaptive management concept (Tony Auld), and a 'confession' (Paul Gibson-Roy) that illuminates why no-one has yet established the *Journal of what went wrong*! Subsequent articles provide the results of translocation trials (Leonie Monks), a summary of learnings in the use of native pastures (Michael Vyse) and from riparian revegetation work (Ashley Bland), and an interview (Adam Birnbaum) with a bush regenerator.

These articles show that while mistakes can lead to unwanted outcomes, they can also lead to unexpected and interesting outcomes that stimulate further investigation, or to better targeting of resources for on-ground works. Deliberate experimental trials can also provide results that help ensure appropriate techniques are used in ongoing conservation activities.

In the remainder of this issue you'll find ANPC President Bob Makinson's report to the November AGM, which also saw two new members – Paul Adam and David Taylor – elected to the ANPC Committee. The issue also contains general articles on threatened plants (Steve Douglas; Jan Allen & Margaret Turton; Kevin Mills) and on an intriguing vegetation type in Tasmania (Maxwell & Tyler). In the regular columns we've caught up on the Research Roundup backlog, and have included a book review and notes on a range of recently published books and websites of interest to ANPC members.

Enjoy reading APC 17(3).

ANPC SECOND NATIONAL FORUM

Minding our own biodiversity: conservation on private land

30 April – 1 May 2009
Halls Gap, The Grampians, Vic.

Details of the forum are provided on the back cover of this issue of *Australasian Plant Conservation*.

ANPC Annual General Meeting, 28 November 2008: President's report

Bob Makinson

Centre for Plant Conservation, Botanic Gardens Trust, Sydney.

Conferences and Workshops

The ANPC's biggest event for 2008 was the 7th national conference, hosted by Mount Annan Botanic Garden and held in April at Mulgoa in western Sydney. Our theme, 'Tackling the threats' to plant species and communities, was addressed at species, eco-community and regional scales. This seems to have helped make the conference optimally accessible for the whole range of our constituency, from site-specific community practitioners through to policy people and researchers. About 220 people attended over the four days, with over 70 papers presented and a good selection of posters. Feedback from the conference has been excellent.

Over the last five years we have presented 25 training courses and workshops in six states and territories. This is a good track record for a small, largely volunteer organisation with only two part-time staff. But there have been some parts of Australia where we have had very little presence, so it was a big breakthrough when, in March this year, Helena Mills and Leonie Monks organised two well-attended workshops in regional WA on the topic 'After the fence – wheat belt woodlands management and restoration'. Sustaining a greater level of activity in the west will be assisted by WA hosting the 8th ANPC National Conference in 2010.

Publications

One of ANPC's key publications of the 1990s was the *Germplasm Conservation Guidelines*. Since its publication in 1997 there has been an explosion of seed research and conservation-oriented seed banking. Recognising this, in 2006 we began to develop a new, fully revised set of guidelines, in collaboration with Australian Seed Conservation and Research (AuSCaR), the consortium of Australian partners of the Millennium Seed Bank. For most of us, this has been bubbling along in the background, but for Cathy Offord (Mount Annan Botanic Garden), Tom North (AuSCaR coordinator) and the various expert contributors, it has been a major piece of work. This second edition of *Germplasm Conservation Guidelines* is scheduled for publication in the first half of 2009, aided by a generous donation of $10,000 from the Australian National Botanic Gardens (ANBG) towards final production costs. Our sincere thanks go to ANBG Director Anne Duncan for that help. The ANBG has a long tradition of promoting native plant knowledge and conservation and of ongoing support for ANPC, which includes hosting of our national office.

Our bulletin, *Australasian Plant Conservation* (APC), has benefited over several years now from excellent thematic planning and production by a succession of editors, including Tricia Hogbin, Tom May and currently Rosemary Purdie. We can be really proud of this publication. The range of articles is broad, the issue themes are relevant and timely, and quality of articles is high. The willingness of people to contribute articles is gratifying, especially authors from the science side of the business who are under a lot of pressure to give priority to papers for peer-reviewed journals. Within its circulation limits (and we do need to broaden those) APC is communicating effectively to the constituencies it is designed to reach.

People

This AGM marks the beginning of a transition process for the ANPC. Two Committee members, both of whom have provided much wise advice and expertise, are not re-standing,

Jim Crennan, who has been Treasurer for three years, has done a tremendous amount to professionalise our financial systems, devoting far more time than we had any right to expect. The Committee has had much better information and forward projections, and has been able to take better decisions as a result. Treasurers are always hard to come by, and we've been lucky to have Jim's expertise. In seeking a new Treasurer we need to stress to prospective candidates that they don't actually need to do quite as much as Jim; he's done many of the hard yards in developing systems, and the job should be a lot easier from now on.

Rosemary Purdie has been a Committee member since 2003, and has done much behind-the-scenes work to build up the organisation's professionalism. Together with Judy West she was largely responsible for crafting our Strategic Plan, and she developed a PowerPoint promo that any of us can use. As APC editor, she has continued to maintain and develop the high quality of editorial coordination and production. We are delighted that even though she is leaving the Committee, she will be staying on as APC editor.

In the next few months we are also losing the services of our two staff members. Sally Stephens joined ANPC as project manager in 2004, bringing 30-odd years of experience in biodiversity management, conservation and communication. She seems to have gone to school or university with, or otherwise knows, just about everybody in the conservation scene. During her time in the Federal public service she organised key conservation conferences and networks, before joining us. That experience has been of enormous benefit over the last four and a half years, with course and event organisation being thoroughly professional (as the evaluation sheets from any of our events attest). It has been a great pleasure for me and the Committee to work with Sally. She has decided that she now wants to escape the desk and computer and get her hands dirty again (possibly volunteering on conservation properties initially), and will be leaving us around the end of February 2009 when we'll be saying proper farewells.

Pam Strickland has been our office manager since 2004, initially at one day per week but growing to three days as she became more indispensable. Pam hasn't set a departure date yet, but will be seeking a full-time job over the coming months. She has been responsible for much of the nitty gritty of the organisation, and has done a great job for us, maintaining smooth events registration and office systems, and handling a lot of member communication. Her energy and sense of humour have buoyed up us all, often when we were about to lose both at times of maximum stress.

The Future

So, over the coming months we will be recruiting staff. This coincides with a gap in our successful run of grant applications, and over the next four months we will have to pull out all stops in developing new funding applications. We currently only have a couple of processes in play, and if we are to sustain both our staffing and the high activity level of the last few years, we need a more or less continual stream of applications going up to funding bodies. All ANPC members can help with this, starting with canvassing the needs for ANPC-type courses (or other activity) in areas they know well, and then developing concept outlines for the type of event that might meet that need. You don't have to be on the Committee to help with this! Please get in touch with any Committee member, or the office, with your ideas.

On behalf of the members I thank the whole 2008 Committee, especially the departing members, and I welcome the new members to be elected at this AGM.

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Adaptive management

Tony Auld

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To effectively manage and conserve biodiversity, we need a clear understanding of those threats that directly or indirectly lead to an increased risk of decline in species, populations, ecological communities or ecosystem functions. At a minimum this includes an understanding of how and where each threat operates, the nature of any interactions between different threats, and how each threat may be changing. An understanding and identification of cause and effect is crucial to the effective management of threatening processes (Caughley 1994). At the same time, our understanding of the ecological processes that control species composition and persistence is incomplete. As a consequence, many possible management actions are limited by uncertainty.

Adaptive Management Concept

The concept of adaptive management (Walters and Holling 1990) seeks to improve our knowledge through clearly designed alternative management options, where the results of these options can then be used to further modify management actions. Such adaptive strategies promote experimentation to spread and reduce risk of failure across alternative actions (Lindenmeyer & Burgman 2005). It is also essential to ensure that any management actions are monitored (using clear and appropriate designs) to inform adjustment and development of threat amelioration measures accordingly over time. All this must be done in the context of limited resources, necessitating priority setting of actions or target species, while minimising the impact of threats across local and landscape scales.

Under a changing climate we must also consider how the goals of adaptive management may change in response to changes in a species' ability to persist in its current environment or to move across the landscape to new areas. This may entail re-thinking and re-defining current management objectives over time.

Adaptive management has been used as a framework to guide the conservation of biodiversity, for example in the management of Kruger National Park, South Africa. The work at Kruger has highlighted that, to successfully implement an adaptive management program, a number of problems have to be overcome, including the incorporation of science into management and policy, maintaining collaboration and the ongoing resourcing of monitoring (Walters 1997; Rogers 1998). These issues should be considered when applying adaptive management to the Australian context.

Adaptive Management – Landscape Scale

An example that highlights the above issues is the beginning of an adaptive management strategy across the landscape in eastern Australia. This involves the development and application of minimum fire return intervals for species and ecological communities. In this case, there has been a clear identification of a direct threat to the maintenance of biodiversity where fires occur too frequently in a landscape (e.g. NSW Scientific Committee 2000; listing under the *Flora and Fauna Guarantee Act 1988* in Victoria).

Considerable uncertainty remains concerning the capacity of individual species to cope with frequent fire, the interaction of frequent fire with other components of the fire regime, and how the probability of frequent fire may change under a changing climate. In NSW, to address this, minimum fire-free intervals have been developed for those species most at risk of extinction (threatened species) as well as for broad-scale vegetation classes (NSW Rural Fire Service 2006). These thresholds are based on detailed data for some taxa and extrapolation for many comparable taxa.

Sampling the fire response of plant species after an ecological burn for restoration. Photo: David Wilks

A register for plant responses proposed by Gill and Bradstock (1992) has been developed in NSW. Monitoring of the fire response of species, along with the time taken to first flowering and development of a seed bank, can then be used to further inform or modify the thresholds and to build up our knowledge of a range of species and ecological community responses to fire.

Landscape scale mapping of fires, both prescribed burns and wildfire, can be used to identify potential areas at risk of being burnt too frequently. This may then lead to direct protection actions for these areas. With time, some of the uncertainty in species' responses will be reduced, while modelling will inform risk assessment under climate change (e.g. Carey *et al*. 2006).

This scheme is still in its infancy and requires ongoing collaboration between researchers, fire managers and those policy makers that determine the legislative context of the scheme.

Adaptive Management – Local Scale

At the local scale, there are examples of conservation management which favour an adaptive management approach. The restoration of remnant habitat areas impacted by weeds is an ever growing area of management focus. In such cases, the key threat is the invasion of exotics, but other issues may also be important, such as nutrification, habitat disturbance, fragmentation, urbanisation and changes to disturbance regimes such as fire.

Determining the best amelioration strategies may be straightforward (e.g. removal of weeds) or complex (e.g. experimental weed control treatments combined with treatments, such as fire or smoke, that promote natural regeneration from a soil seed bank). In the latter case, we need to learn both how effective different control treatments may be, as well as the capacity of the habitat to respond to treatments aimed at trying to mimic natural disturbance regimes.

Alternative strategies may also carry a risk element for biodiversity, within the context of the local area, that may be quantified in the treatment application and subsequent monitoring. For herbicide application this would include impact on non target species. For smoke application, smoke may promote germination from a soil seed bank without a concurrent reduction in fuel levels, and there may be a risk that fire will eliminate this recruitment in the near future. Hence monitoring schemes need to be sufficiently robust to cover a range of possible impacts.

Key Points

A key message for those seeking to apply an adaptive management framework is to identify threats and design sound ameliorative measures and monitoring schemes that will increase our knowledge of the response of the flora to the range of possible amelioration measures. Where considerable uncertainty exists, alternative strategies should be trialed. It is critical to have sound objectives. Too often we fail to ask the right questions or to undertake monitoring that will provide us with relevant answers to our questions. At the same time, we need to consider how to integrate such schemes into land management programs and legislation to ensure their long-term uptake.

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Had I mixed those damned vials of smoke correctly …

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Introduction

People (me among them), are often heard to discuss the benefits of 'learning by one's mistakes'. It's not that making mistakes is particular fun; they just seem to go hand in hand with being human. They might result just in frustration and loss of time, but can also lead to serious and costly outcomes. For example, an inadvertent communication error by someone involved with my work once resulted in the destruction of a field sowing that had cost approximately $20,000 and countless hours of input from many committed people. Conversely, very interesting things can be learnt from errors, about one's self and about the world around us.

I've often attended forums and workshops where participants suggest enthusiastically that we should communicate more about 'how not to do things' or 'what went wrong', as much as we communicate about 'how to' and 'what went right'. While admirable, sometimes it takes a brave soul to identify, before all and sundry, past errors or mix-ups. To illustrate this point, few scientific journals appear committed to reporting errors! And, having agreed to write an article for this issue (who hasn't made plenty of blues along the way?), I've been looking at a blank page for many months. Possibly there's a degree of reluctance on my part to publicly 'fess-up' to being a dill. But how do you 'report' on what were often fleeting events, the consequences of which were not always immediately obvious?

My Story

I'll focus on an event that occurred when undertaking my honours degree at Melbourne University. My supervisor at the time (and now dear colleague through many years) was John Delpratt. I had become captivated by John's work with grassland species and was making my first tentative steps into the world of grassland restoration. I was also beginning to understand the level of detail and focus required to undertake research. I had begun by looking at the potential of a suite of seven indigenous grassland species to germinate and establish following direct seeding under quasi-field conditions. Collecting seed for the experiment, testing the seed prior to sowing, organising seed-lots, preparing the experimental plots for sowing and obtaining materials for the various treatments had taken months and months of effort.

Grassland species flowering prolifically within the duplicated seeding study twelve months after sowing. Photo: Paul Gibson-Roy

The design of the experiment was relatively straightforward. I was interested in the effect of different seeding rates and altered nutrient regimes on the short- and long-term success of the sowings. At the time, there was much discussion about the possible beneficial effects of smoke in promoting germination (a topic still of considerable interest in the regeneration industry), and decided to apply smoke as a background treatment across all sowings.

At about 6.00 am on a fine Saturday morning, the time for actual sowing had arrived. I thought I'd covered every base and had lists to check-off on a regular basis. Seed-lots mixed with 'X' amount of smoke product, bulked up with 'Y' amount of vermiculite, sown onto good seed bed, pressed in, fertilized if required at 'Z' rate and watered in, etc etc. By 6.00 pm I was exhausted, and rang John to proudly inform him of the day's events.

Being the meticulous person John was/is, we discussed the various aspects of the sowing in detail and I spoke of each with some confidence – that is, until a passing comment of his sent a cold shiver up my spine. We had spoken about the calculation I had used to determine the rate for applying the smoke product to a particular surface area. I realised that I had inadvertently added a zero to my figure at the point of mixing and therefore increased the application rate by a factor of ten. It was not obvious at the time because the volumes of smoke product were extremely tiny. What to do? Of course I wanted to throw up, but held my nerve. I reasoned that no-one would ever know if I didn't mention it. To start again would take an enormous effort. I did have the seed but wasn't sure if I had the constitution or will.

In the end, following a pretty ordinary Sunday, I did fess-up on the Monday. After some discussion with (and counselling from) John, I duplicated the experiment using the correct recommended rate of smoke product. In the following weeks and months through to the completion of the experiment, I discovered that the species I'd planted responded in very interesting ways to the particular rates of smoke that had been applied. While some species struggled in the 'high' smoke plots of the first sowing, one species germinated at very high rates.

What Did I Learn?

So what did I learn from my 'error'? I certainly realised I could never be 'sloppy' with my maths, especially when working with concentrated substances. I also realised, however, that the seed-related outcomes of the 'error' were extremely interesting. After undertaking further investigation, I found that the seven grassland species I tested at varying smoke rates had differing dose responses to the smoke product. To my knowledge, there is still no commercially available smoke product that delivers a quantified amount of the active ingredients in smoke that promote germination. In lieu of this, propagators and restorationists apply smoke in various forms at essentially 'unknown' or 'ball-park' rates. This means that we probably often see species responses that differ from application to application, or from one form of smoke to another, or in results from one person to another. Only when products are supplied with known amounts of the active smoke ingredients will we be able to confidently test the dose responses for species and understand exactly 'how much' (if any) promotes germination for a given species. We will then be in a better position to apply smoke with confidence in the field or propagating room (being mindful, of course, of one's sums when mixing).

Conclusions

When I began this article I had a lengthy list of 'errors' I was going to report. However just getting this one event off my chest has taken up the word limit (and been cathartic enough!).

The comment 'To err is human' has been made by wise people on many occasions over a long period of time, and seems to be a fair enough statement. Thus, armed with a knowledge that we are likely to err, how do we proceed?

I learnt that undertaking research requires attention to fine detail and I must be especially careful in this respect. However, more importantly, it alerted me to the fact that errors can lead to very unexpected and interesting outcomes. In my case, at the time of realising the error, it took a huge amount of will to own up to something that no-one would have ever known about. But had I not, the duplicate experiment would never have been instigated. Despite the considerable effort the duplicate required, I was alerted to a whole new set of findings that I would not otherwise have suspected nor investigated, had I mixed those damned vials of smoke product correctly the first time.

Experimental approaches in threatened plant translocations: how failures can still lead to success

Leonie Monks

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Introduction

Translocations are increasingly used to aid in the recovery of threatened plant species. This is achieved by augmenting declining populations and supporting species recovery through the establishment of new populations. Translocations are often thought of as a quick fix solution to prevent species or population extinction. However, translocations require detailed planning prior to establishment, followed by long-term monitoring and maintenance. Without this they are likely to fail.

The aim of plant translocations should be to create viable self-sustaining populations (biological success). However, broader success criteria should also be considered (project success). These project success goals should not only encompass biological success but include additional goals, such as learning more about the translocation process and communicating these results (successes and failures) to the wider conservation community to allow others to gain from the experience (Pavlik 1996).

In Western Australia plant translocations have been used in the recovery of threatened plant species since the early 1990s. In most cases the fate of the plants from these early translocations were not adequately monitored. Consequently, little knowledge was gained that could improve the success of subsequent translocations.

Since 1997 the Department of Environment and Conservation has commenced translocations for 44 threatened plant species and ensured these were established in a way that knowledge could be gained from any successes or failures. In most cases the translocations were established as experiments with the aim of creating viable populations, and refining translocation techniques. In order to achieve the latter aim, a range of practices commonly used in horticulture were investigated for their potential to enhance the survival and growth of the translocated plants in a cost-effective manner. The results from experimental trials of three common treatments are reported here.

Experimental Trials

Tree guards

One of the techniques trialed was the use of plastic tree guards, which are commonly used in roadside and restoration plantings to protect plants from frost, wind and herbivores. They are also thought to enhance growth by elevating humidity and concentrating carbon dioxide. To test whether the use of tree guards improved survival or enhanced growth of translocated seedlings, a trial with the critically endangered *Lambertia orbifolia* subsp. *orbifolia* (Round Leaf Honeysuckle) was established in 1998.

At a translocation site located north of Albany in south-west Western Australia, 108 seedlings were planted. Half the seedlings were given tree guards (approximately 0.5 m in height and 0.3 m in diameter) and half were fenced with cages made from wire netting (0.9 m in height and 0.5 m in diameter). Fencing the plants without tree guards meant comparisons of the effectiveness of tree guards in preventing herbivory could not be made, but other benefits could still be assessed. Annual assessments of survival, height and crown width were undertaken. However, as the plants grew taller than the tree guards by the end of the second year, it was considered that the main effects of the tree guards would be seen in the first two years.

At the conclusion of the first and second years there was no difference in survival between the plants with and without tree guards ($P = 0.35$, $P = <0.01$) (Fig. 1A). Plants with tree guards grew taller than plants without tree guards in the first year ($P = 0.01$), but by the second year this height difference was no longer significant ($P = 0.47$) (Fig. 1B). Conversely, plants with tree guards had narrower canopies in the first year than plants without tree guards ($P = 0.28$) but this had reversed by the second year ($P = 0.26$) (Fig. 1C).

It appears that horizontal canopy growth is constrained by the tree guard and therefore plants grow vertically more rapidly than plants without them. Once taller than the tree guards, horizontal canopy growth can occur. The site location may also have played a role in the effectiveness of the tree guards. Located amongst shrubs, with a woodland overstorey, frost and wind are unlikely to have had a significant impact on plant survival or growth.

Shade

It was hypothesized that translocated seedlings provided with shade would survive better and have greater growth than those seedlings without shade, due to less transpiration. We implemented this technique when translocating the critically endangered *Banksia* (formerly *Dryandra*) *ionthocarpa* subsp. *ionthocarpa*. We planted 95 seedlings in winter 1999 at a translocation site north of Albany. After planting, each plant was enclosed in a circular cage made

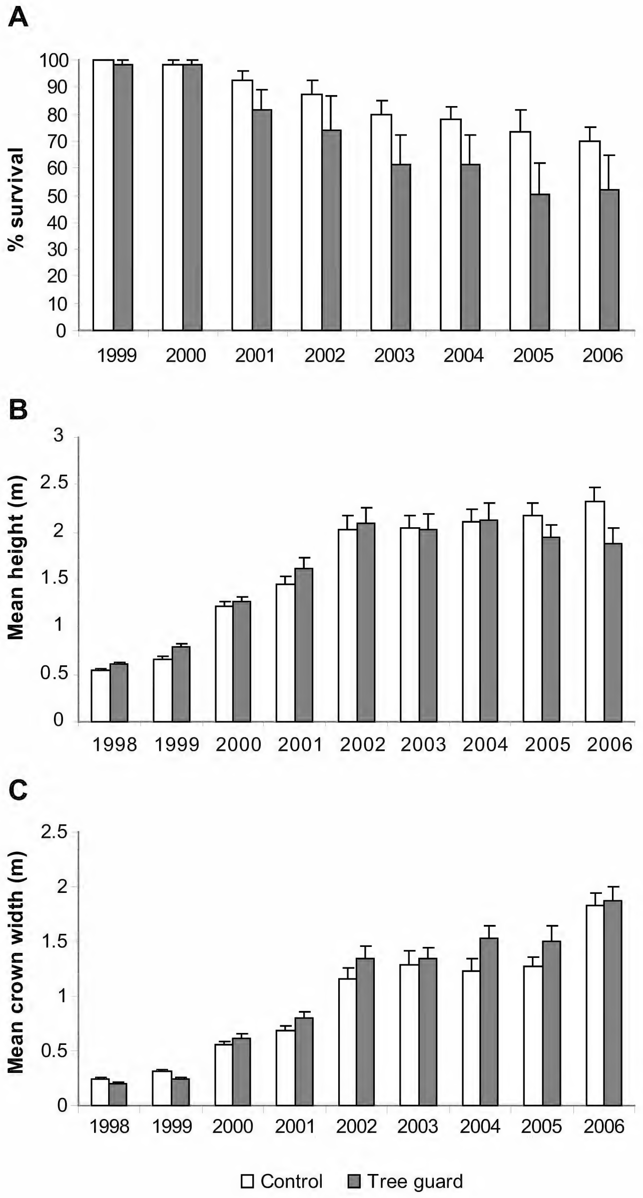

Figure 1. Translocated Lambertia orbifolia *subsp.* orbifolia *seedlings, between 1998 and 2006: percent survival (A), mean height (m) (B) and mean crown width (m) (C) of seedlings with (dark bars) and without (white bars) tree guards.*

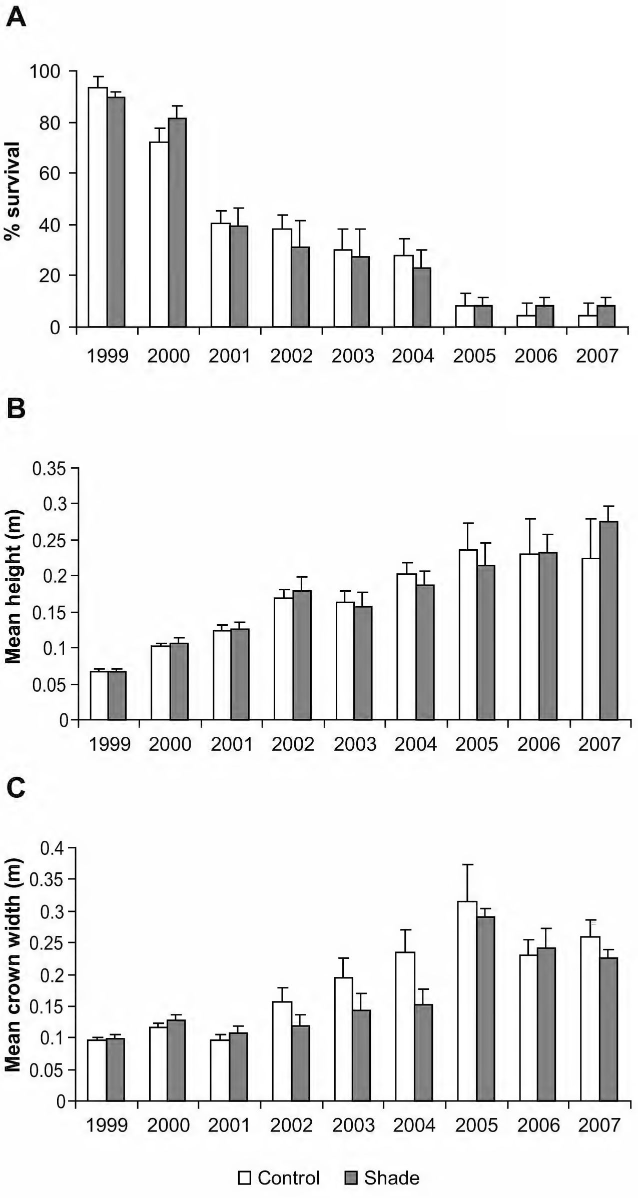

Figure 2. Translocated Banksia ionthocarpa *subsp.* ionthocarpa *seedlings, between 1999 and 2007: percent survival (A), mean height (m) (B) and mean crown width (m) (C) of seedlings with (dark bars) and without (white bars) shade.*

of wire netting (0.5 m in diameter), which was open at the top. Half the seedlings had the cages covered in 80% block-out green shade cloth (shaded treatment) and half were left unshaded (control).

After eight years, overall survival was very low, with just four seedlings surviving in the shaded treatment and two control seedlings (Fig. 2A). The difference in survival was not significant ($P = 0.57$). Shaded plants were slightly taller on average (0.28 m) compared to the control plants (0.22 m) but this was not significant ($P = 0.67$) (Fig. 2B). In contrast, control plants were slightly wider (0.26 m) compared to the shaded plants (0.22 m), but again this was not significant ($P = 0.07$) (Fig. 2C). Overall, shading did not significantly enhance survival or growth, and survival of translocated plants was poor in general.

Mulch

The use of mulch is widely encouraged in garden and horticultural plantings as it is thought to aid water retention and help reduce soil temperature around the root zone. We tested whether mulch could enhance the survival and growth of translocated seedlings when augmenting a small population of the critically endangered *Daviesia bursarioides* (Three Springs Daviesia). We planted 96 seedlings into a nature reserve 300 km north of Perth in August 1998. Half of the seedlings had sterilized mulch (made from ground-up tree loppings) spread around their base in a 1 m diameter area and thickness of 2-3 cm; the remaining seedlings had no treatment. Plants were monitored for growth and survival annually or biannually.

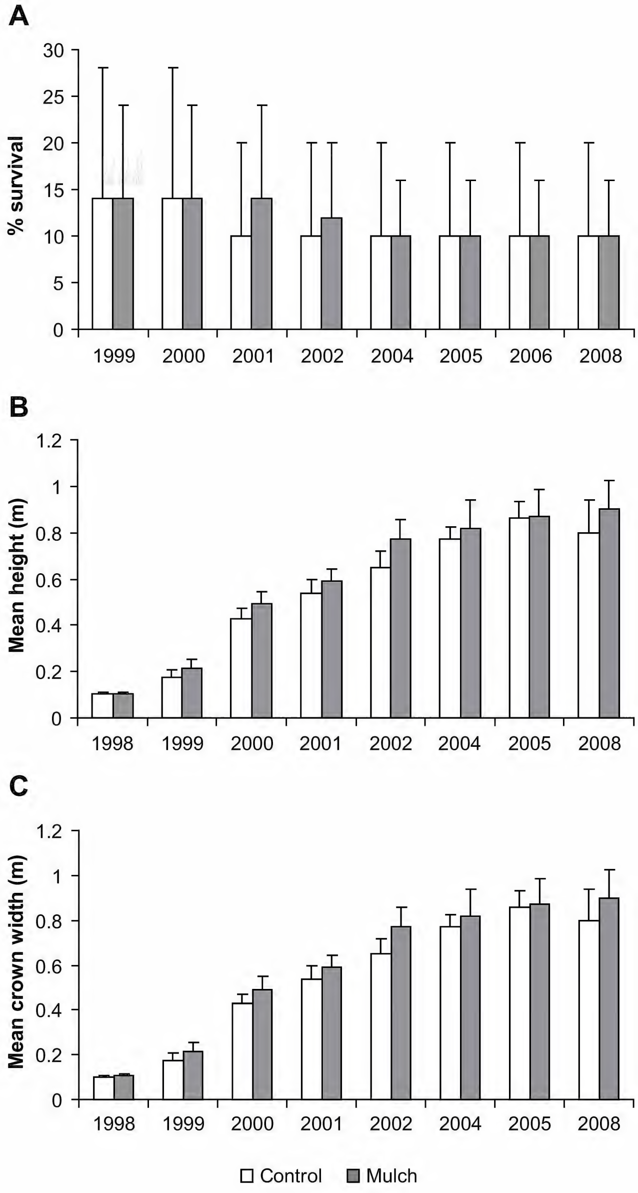

Figure 3. Translocated Daviesia bursarioides *seedlings, between 1999 and 2008: percent survival (A), mean height (m) (B) and mean crown width (m) (C) of seedlings with (dark bars) and without (white bars) mulch.*

The use of mulch did not improve plant survival, with only 10% of plants in both treatments persisting after ten years (Fig. 3A). Addition of mulch also did not result in greater growth compared to plants with no treatment (P = 0.37 for height and P = 0.49 for crown width) (Figs 3B and 3C).

Conclusions

None of the three translocations discussed could be considered successful in a biological sense. In all cases plant survival was low and the resulting small populations are unlikely to be viable in the long term. However, with failure also came success.

The results from the tree guard trial suggest that the guards did not work in that situation, and consequently tree guards have not been used in subsequent, more successful plantings of *Lambertia orbifolia* subsp. *orbifolia*. The shade trial revealed time and resources would be wasted, if adopted on a large scale for *Banksia ionthocarpa* subsp. *ionthocarpa*, as this technique was not successful in decreasing the taxon's plant mortality or increasing plant growth. The mulch trial with *Daviesia bursarioides* showed that the added expense and time for this treatment had no apparent biological advantage, although the trial was successful in that the results have aided subsequent translocation efforts by reducing costs and staff time.

The above results demonstrate the importance of small-scale trials of new techniques aimed at improving plant survival, rather than assuming what works in other plant industries will also work for the species and environments we are required to manage. The design and establishment of translocations and subsequent collection and dissemination of knowledge about what techniques do, or do not, improve translocation success is critical to achieving optimal results in a cost-effective manner. This ensures broader translocation criteria are met and increases the likelihood of creating viable self-sustaining plant populations.

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Biodiversity and ecologically sensitive grazing: collected extracts from 'Biodiversity in the paddock: a land managers guide'

Compiled by Michael Vyse

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CSIRO and the Future Farm Industries Cooperative Research Centre have just published research that makes clear the notions that biodiversity can complement farm business and that native pastures can be profitable. The booklet they have produced is based on past and current research and the personal experience of 24 producers on the south-western slopes of New South Wales and inland slopes of Victoria with whom the scientists have been working.

Research surveys on these properties were undertaken during 2006 and 2007, seasons of well below average rainfall. The booklet presents a snapshot of the lessons learnt for biodiversity.

On many south-east Australian properties, native pastures make up 65% or more of the grazing area and are the most widespread form of native vegetation. This landscape was once woodland but now supports a range of land uses. The native pastures in this region are important for commercial production but also play a critical role in maintaining native biodiversity and healthy landscapes. Low and high input native pastures (see below) are the two most widespread types.

Low input native pastures are those that have experienced prolonged grazing with little or no fertiliser use. Productivity is low, and low stocking rates are typical. They can support high plant diversity as they may contain a mix of grazing-dependent as well as grazing-sensitive species. There may be a wide range of life-forms, including tall and short grasses, flowering herbs and low shrubs.

High input native pastures have developed through greater levels of fertiliser use and a resulting increase in stock grazing pressure. They can be highly productive, and support a small group of native grass species. Exotic annual clovers, non-native grasses and broad leaved weeds are often common pasture components.

There is growing recognition of the role of native pastures in landscape health, including soil protection, water quality and low risk management in the face of climate change. These pastures are also important for the survival of many native plant and animal species – the biodiversity in the landscape.

Low input native pasture. These contain a mix of grazing-dependent and grazing-sensitive native plant species. Photo: Jacqui Stol

Some key findings and messages from the research are summarised below.

Grazing

The research has not found an increase in native plant or animal diversity under any particular grazing regime, although other benefits can be gained through planned grazing systems that provide long pasture rest periods. Key things to consider when grazing to maintain biodiversity are:

- grazed native pastures can have significant plant, bird and reptile diversity;
- high diversity occurs with low stocking rates;
- seasonal rest can be an important strategy for increasing perennial groundcover;
- rotational grazing can provide managers with better control over stock pressure and distribution;
- continuous grazing at low density can provide important habitat and plant diversity;
- a diversity of management equates to a diversity of species; and
- it is important to monitor pasture composition and grazing pressure to track changes in native pasture biodiversity.

Fertiliser

Half the producers surveyed in the research did not fertilise their native pasture. Key findings related to fertiliser use include:

- it can be more profitable to reduce fertilisers in native pastures and concentrate its use in sown pastures and crops; and
- increased nutrients lead to decreases in native plant diversity; native plant diversity can only be increased when fertility is low.

Plants for Pasture

Maintaining a diverse native pasture is a low risk and low cost approach to pasture management, through efficient capture and use of water and nutrients and a permanent biomass. When considering managing pastures for productivity and biodiversity, the following information is important:

- the diversity of plant species and life-forms is reduced by fertiliser use and heavy, prolonged grazing;
- low fertiliser inputs and conservative grazing don't maximize productivity, but do provide functions such as soil protection and drought resistance; and
- management determines the composition and the ecological function of pastures, so always monitor for changes.

On the Ground

A diverse ground layer habitat is composed of a variety of grass tussocks and wildflowers, and shrubs, ground litter, fallen timber, surface rocks and even bare earth. These are all critically important elements for the maintenance of biodiversity and a well functioning pasture ecosystem. Key messages include:

- birds, mammals, reptiles and insects require habitat that includes a diverse ground layer;
- to manage for production and biodiversity, aim for 70-100% cover of native grasses, litter, logs etc.; and
- a diverse range of ground layer elements is the best underpinning for long-term, low-input, low-risk grazing.

Trees

Paddock trees, such as Yellow Box (*Eucalyptus melliodora*), White Box (*E. albens*), River Red Gum (*E. camaldulensis*), Red Box (*E. polyanthemos*) or Red Stringybark (*E. macrorhyncha*), provide an important cultural and ecological link to earlier extensive woodland systems.

Paddock trees are an important source of seed for regeneration, and natural regeneration can be more cost-effective than planting or direct seeding. Continuous year-long grazing and high soil nutrient levels reduce the health of adult trees and prevent regeneration. However, the right combination of grazing management and seasonal conditions will increase the chances of seedlings becoming established. For best results, paddocks with a good population of scattered trees and a low fertiliser history should be targeted.

Soil

Land managers need to identify places on a farm or in a catchment that are most prone to soil surface erosion and rapid water run-off. Protecting these areas from heavy grazing, encouraging biological soil crusts (for example, a cover of lichens) and the build up of litter and perennial plant cover will help retain water, soils and nutrients on the farm. The key messages are:

- fertilised, heavily-grazed soils are more prone to nutrient loss and erosion; and
- in low fertility environments, biological soil crusts protect soils from erosion but can be disrupted by grazing.

Climate

During the 2006 drought, live native perennial plant cover on the slopes of southern NSW and north-eastern Victoria was little affected by drying conditions. Native perennial plant abundance was largely determined by grazing pressure and past fertiliser use. Pastures dominated by exotic species quickly collapsed under the worsening conditions. During the same drought, properties with rotational systems with few grazing days and long rest periods retained greater 'bulk' with more litter between tussocks. This litter is not as resilient as live plants, but it insulates soils and helps retain moisture, and provides some protection against wind and water erosion. Key messages include:

- managing for high productivity and biodiversity requires identifying the most suitable paddocks for varying uses; and
- focus on areas with a history of little or no superphosphate application for revegetation and restoration.

More Information

This article is a compilation of extracts from Biodiversity in the paddock: a land managers guide *by Josh Dorrough, Jacqui Stol and Sue McIntyre from the Victorian Department of Sustainability and Environment and CSIRO Sustainable Ecosystems. The whole document can be downloaded from <www.csiro.au/resources/biodiversityinthepaddock> and <www.futurefarmcrc.com.au>.*

Down by the riverside: lessons to be learned from low success in revegetating a riparian corridor

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Introduction

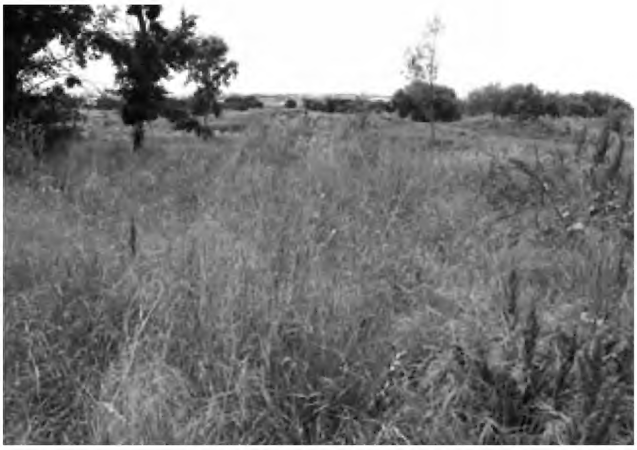
Volunteers are often engaged by various local government councils, natural resource management (NRM) bodies and community groups to provide the community engagement aspect of a revegetation or rehabilitation program. Often the volunteer has little say in the techniques used and/or project management, instead being directed by the expertise of the sponsoring agency and fulfilling a labour role. In the field this results in a full range of outcomes, from award-winning success to hard-learned lessons. One thing that is constant though is that volunteers need to feel as though the work they do is making a real and positive difference.

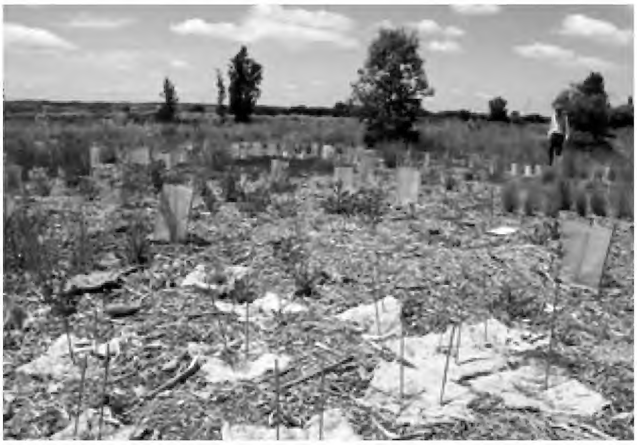
Volunteers are an accepted part of the NRM industry, accounting for significant outcomes, be they via groups such as Landcare, Coastcare, Bushcare, National Parks, etc or just as motivated individuals. We owe it to these people then, who give up their own time and energy, to utilise their effort to the best degree. Unfortunately this is not always the case. The following example that illustrates this point occurs in a regional town (to remain nameless) which could be one of many. In their defense, the managers of this site have been using standard revegetation practices and are genuine in their significant attempts to improve the region.

Some No/Low Success Sites

Despite its appearance, Figure 1 has not been included to show a healthy pasture. What it does show is the site of a mixed, multi-species planting as part of a $200,000 revegetation program over approximately 800 m of riparian corridor. There are empty grow-bags hidden in this image! The volunteers who planted here were under constant skilled supervision, so we can assume that tube-stock were mostly planted correctly. In terms of erosion stability in a flood-zone, this site is a success, but given that the aim of this part of the project was to re-introduce native species for habitat, the site has been a failure. The lack of success was due to several factors.

Firstly, continual follow-up watering or weeding had not been budgeted for or programmed, and so very little occurred beyond the initial work period. Admittedly the planting was done in 2006, a dry year, in which case planting could have been reduced to allow money to resource watering. Having said that, what would the nursery do with ordered stock or what facilities would the Council have to care for the left-over plants? Those plants which were able to survive the dry period were then out-competed by the aggressive grasses, including *Phalaris* and broad-leaf weeds such as *Rumex*.





(top to bottom) Figure 1. Where are the grow-bags? Figure 2. A site with a low, but improved, strike rate. Photos: Ashley Bland

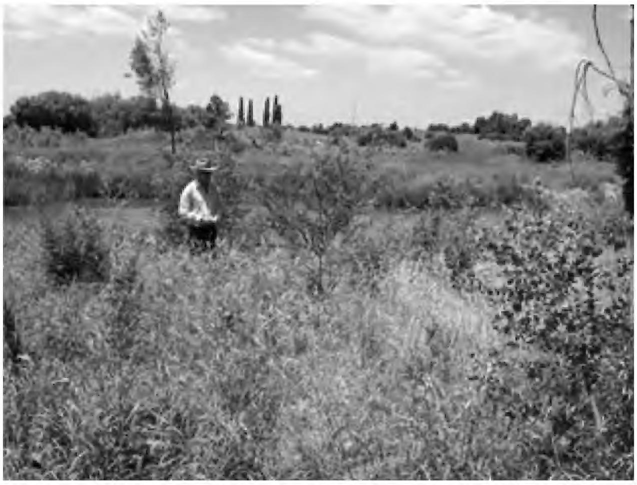
The second reason relates to the first in that the trees were planted in a freely draining sandy soil using techniques appropriate for loam or higher clay content soils. Again, the budget had allowed for a certain number of stems, but not for appropriate planting products like water crystals or techniques such as long-stem planting.

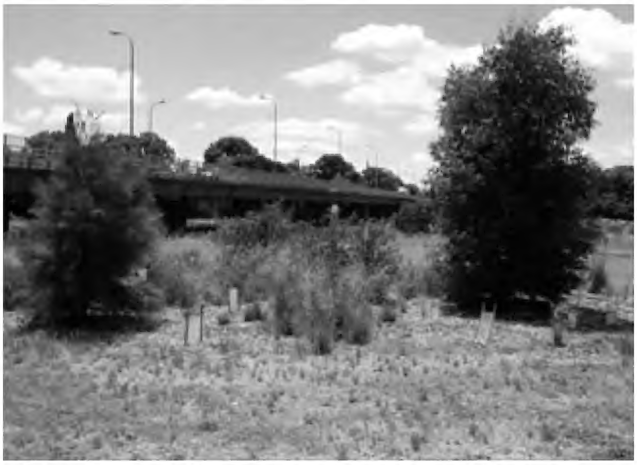
Figure 2 indicates a site about 200 m from that shown in Figure 1. In this instance heavy mulching and some follow-up weeding has reduced the impact of competition. However, for the same reasons listed above in relation to water, there has been only a 10-15% strike rate after two years. The larger trees in the background are from earlier, equally unsuccessful plantings.

A further point is illustrated in Figure 3, which shows a <10% strike rate in the foreground and the absence of any typical riparian gallery structure along the river banks in the background. The blanket removal of willows from this entire section has resulted in a radical change of habitat with little thought of consequence. It has been positive to see *Phragmites australis* establishing on the river margins, but the bulk of the beneficiaries of increased light are the very healthy looking typical inland riparian weeds. There is now reduced structural complexity, and one would expect reduced biodiversity as a result. It is ironic, not to mention wasteful of community goodwill and tax dollars, when projects which set out to improve ecological condition do the opposite.

A Successful Site

There were some examples in this river project that have achieved greater success. Figure 4 shows a cluster planting with an 80% strike rate and grasses, forbs, shrubs and trees in an appropriate distribution. Reasons for the success of this plot lie in the fact that it is on loamy soil, and that it was highly visible and easy to access, which resulted in more follow-up maintenance.





(top to bottom) Figure 3. A site that has lost its riparian vegetation structure. Figure 4. Cluster planting with a good success rate. Photos: Ashley Bland

Impacts on People

All of the factors leading to poor results at a site, whether fully comprehended by the volunteers or not, are no doubt demoralising. We, as an industry, lose credibility with the public when projects result in such poor outcomes. It requires skilled leadership, if not some creative reasoning, to engage volunteers in continuing projects that have obvious failure rates.

None of the factors leading to failure are likely to be surprising for the majority of people involved in NRM – it is, as they say, ‘not rocket science’. So why do failures still happen? The answer lies at least partly in human motivations and organisational bureaucracy. Big numbers are more impressive than small ones, budgets need to be spent by June 30, it’s easier to do the whole job the same way, and it’s safer to do it the way everyone else does.

Learnings from the Project

So what can we learn from the river project discussed here?

1. Revegetation projects need to be well thought through, including not just site conditions but also social factors – especially the ability or willingness of communities to take on maintenance of the plantings if the sponsoring organisation does not.
2. Funding design should allow for contingencies, i.e. what happens if it doesn’t rain? How will I control the weeds in 12 months time?
3. Revegetation work is about quality not quantity. The true cost of planting, if aiming for high success rates in difficult terrain and an unreliable climate, is probably closer to $10-15 per plant than $3 per plant. High failure rates raise the per plant cost anyway – in this case study, to around $500 per tree (not to mention the cost of doing it again!).
4. Plan for small variations on single project sites. Microhabitats and varying soil types can have a big influence on revegetation techniques as well as species selection and placement.
5. Be patient; don’t try to do it all at once.

Again, we owe it to our volunteers and the community in general to do everything we can to maximise success in revegetation projects. Instead of aiming for big numbers and quick blanket fixes, we should be working on encouraging community stewardship and targeting manageable projects.

Interview: a bush regenerator's perspective

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Introduction

Since 2003 Steve McRae has run his own bush regeneration company Australian Area Management and Restoration (AAM&R), servicing the northern beaches of Sydney. In the following interview I carried out with him, Steve reflects on his experience. My questions (Q:) are shown in bold.

Q: How do you believe bush regeneration is linked to biodiversity?

Pockets of bushland that have become infested with weeds or disturbed by human activity tend to be dominated by a few species only. The weed species often dominate to such an extent that they create an environment inhospitable to the native diversity that may otherwise occupy that space. Weeds can change soil chemistry, sunlight, hydrology, available habitat for native species, encourage or introduce faunal pest species and disease. All of these factors may displace native diversity and limit the number of niches available within an ecological community.

'Islandisation' presents another threat to the survival of genetic material or a species. A small genetic pool limits the opportunity for a species to adapt to altering conditions and threats. By retaining pockets of bush with a reasonably healthy, representative diversity, corridors will remain open and allow the transfer of genetic materials between populations.

Bush revegetation efforts within a Chrysanthemoides monilifera *subsp.* rotundata *(Bitou Bush) stand. Photo: Adam Birnbaum*

Q: What are some successful techniques you have used, and any unsuccessful trials you have implemented?

Bush regeneration is a broad school. Approaches to work practices are as much a product of practicing of philosophies as reflections of productive work practices. AAM&R has generally taken on contracts that have defined objectives with a described work practice comprising a beginning, a middle and an end.

Selections of any area for regeneration work could be considered a trial. The choice should be made based on site condition and level of input that may be available to the site. Unfortunately, many projects are based on political or public relations requirements, and high levels of resources may be poured into areas that are higher profile rather than higher resilience or ecologically valuable.

Success or otherwise reflects:

- the quality of the areas chosen for work;
- the attention to detail by the staff doing the work;
- how long the project is expected to run; and
- the amount of maintenance conducted during the time of the project.

One volunteer group that I have been associated with has been trying to encourage regeneration in one particular area of a site for eight years. They had been working this area for several years prior to my association with them. They use Bradley-like techniques of repeated weeding and allowing recruitment from surrounding bushland with reasonable diversity and utilising the soil seed bank. To date there have only been a few *Omalanthus nutans* regenerate here. This is a common pioneer species probably delivered via bird droppings. This volunteer group was encouraged to consider revegetation rather than regeneration. The idea was dismissed.

It is the site of an old rubbish tip with a disturbed or non-existent soil seed bank. Unknown materials have been deposited which may create problems such as incorrect pH levels for native plants. Though at this stage our company has not done any sandstone capping we have planted into these sites. The idea is to create a barrier too thick for germinating weed seeds to penetrate. The barrier should be a minimum of 150-200 mm thick. Where this depth is not achieved and where excavator operators have not used good hygiene practices, the benefits of this process can be lost and the offending weeds may penetrate the capping or be reintroduced to the surface of the barrier, thus undermining the value of the whole process.

Q: What have you learnt from both the successful and unsuccessful practices?

Pure regeneration is a nice idea, but it requires a specific set of circumstances to work, including undisturbed soil profiles, close proximity to bush that may contribute by being a seed source, and regular and high level input of labour for maintenance (which may be achievable with a few of the right sort of volunteers). Older style (Bradley) regeneration methods may get a small area of a reserve looking almost garden-like, but this is of little value if the ecology of a greater part of the site is lost. There is an acceptable level of weeds on a lot of sites, as native fauna will still employ this for food and habitat and therefore help maintain the ecology of the site.

Q: Are there any projects you have worked on in the past that you look back on now and think you should have approached differently?

Over the past years both success and failure seem to be around revegetation jobs. I recall being involved in a weed control and revegetation project, whilst working for another company. This was road verge planting to replace noxious weed species growing in an otherwise highly disturbed strip. The company allowed little or no time for establishment watering and used no water crystals to maintain soil moisture during the establishment period. Having passed this road regularly, there has been a less than 30% survival rate of these plants.

The flip side of this has been a revegetation job at Yaruga Creek for Manly Dam. We planted between 6,000 and 10,000 plants on a remote exposed sandstone-capped area using water crystals. We had a survival rate in excess of 95%. The crystals require very little extra time or effort to install. They may cost an extra 4c per plant at the most as far as material costs are concerned, compared to around $4.00 per installed plant, but this is an investment with significant return.

I am looking for projects to use other supports such as animal repellents or deterrents in areas to encourage regeneration. The opportunity hasn't yet arisen.

I have learnt that some council land managers are ridiculously conservative and are happier having crews endlessly hand weed in keeping with the past practices of bush regeneration, rather than engage progressive techniques.

Q: When do you believe it is better to undertake revegetation, rather than regeneration?

Regeneration may be effective in areas that are close to or within a relatively complete or undisturbed bushland. There needs to be a source of seed or opportunity for regeneration from within, without supplementing from outside of the immediate area. If the soil profile has not been disturbed or removed, covered or contaminated, there is a potential for regeneration from a dormant soil seed bank.

Often areas that have been severely disturbed, (e.g. from demolition, land fill, mines, road verges, or creek lines that have been excavated to create storm water canals and then re-established) are devoid of a seed bank or have an altered hydrology or soil chemistry. These sites would be considered for revegetation.

Q: How do you determine what species you select for revegetation works?

Consideration would be given to local community composition as well as which communities would most likely occur given the abiotic factors. Soil, terrain, aspect and hydrology are some of the dominant factors for consideration.

Q: How would you go about monitoring the success of new methods, such as animal repellents?

Many of these works are done on a shoestring budget. It may be possible to mark test areas and monitor the difference between project areas and 'control plots'. Comparison with areas previously planted that have been eaten may also indicate success or otherwise, in a similar manner to the results from using water crystals.

CALL FOR NOMINATIONS

The *Environmental Protection and Biodiversity Conservation Act 1999* (the EPBC Act) provides for the listing of nationally threatened native species, ecological communities and key threatening processes. Threatened species and ecological communities listed under the EPBC Act are protected as matters of national environmental significance.

The Department of the Environment, Water, Heritage and the Arts is inviting nominations for items to be include in the EPBC Act lists of

- threatened species,
- threatened ecological communities, and
- key threatening processes.

Under section 194E of the EPBC Act, nominations will be considered for inclusion in the priority assessment list for the assessment period commencing on 1 October 2009.

The conservation themes for this assessment cycle are:

- terrestrial, estuarine and near-shore environments of Australia's coast, and
- rivers, wetlands and groundwater dependent species and ecosystems of inland Australia.

Nominations consistent with these conservation themes are encouraged, but nominations outside the themes will also be considered for priority assessment.

Nominations close at **5 pm on Thursday, 26 March 2009**, and can be submitted in electronic or hard copy format.

For more information, contact the Director, Species Listing Section (phone: 02 6274 2238; email: epbc.nominations@environment.gov.au) or visit the website **http://www.environment.gov.au/biodiversity/threatened/nominations.html**.

Australian Government

Department of the Environment, Water, Heritage and the Arts

Species profile and monitoring of *Dampiera fusca*

Steve Douglas

Ecological Surveys & Planning, Albury, NSW.

Description and Conservation Status

Dampiera fusca (Goodeniaceae) is an erect, multistemmed perennial subshrub growing to 30 cm high, that produces large numbers of iridescent blue or occasionally white flowers. A detailed description is provided by Carolin (1992) and Alston *et al.* (1993).

The species is endemic to the highlands of south-eastern Australia. It is known from a single population in the ACT (Namadgi National Park), three populations in far south-eastern NSW (Wadbilliga National Park, Tinderry and Coolumbooka nature reserves), and a multipart population in the north-eastern highlands of Victoria's Alpine National Park. The species occurs in montane heath/scrub and montane to subalpine woodland/low open-forest between about 800-1400 m above sea level. Substrates are generally granitic or metasedimentary.

Dampiera fusca was recently listed as Endangered under the NSW *Threatened Species Conservation Act 1995* (NSW Scientific Committee 2007) and is similarly listed under the Victorian *Flora and Fauna Guarantee Act 1988*. Its status is under review in the ACT, where it was discovered after the 2003 wildfires that burnt much of the northern Australian Alps (Douglas 2005, 2007). The species warrants nomination at least as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Threats

Climate change

The impacts of current and predicted anthropogenic climate change on *D. fusca* include habitat loss through increased erosion of its readily desiccated and exposed habitat, altered competition dynamics that could disfavour *D. fusca* relative to its competitors, higher temperatures and increased moisture stress. The latter two factors may reduce the area of *D. fusca* habitat, forcing it further upslope, although in all known locations this is not possible without translocation, or unless the species manages to disperse and colonise higher areas. Climate change is also likely to change natural fire regimes and may further constrain the use of deliberate regenerative burning of habitat.

Feral animals

Feral goats, pigs, rabbits and horses have been identified as potential threats to *D. fusca.* Goats and horses are likely to be the more problematic due to the nature of the terrain and vegetation at most if not all *D. fusca* sites. Rabbits are a significant concern at the Namadgi site (Douglas 2007) and may be an issue at other sites, particularly the relatively similar Tinderry location. Browsing and habitat erosion are the major concerns.

Altered fire regimes

What little is known of *D. fusca's* fire ecology suggests that the species may be at risk from both too frequent fire (leading to unsustainable depletion of the seed bank) and insufficiently frequent fire (leading to possible medium- to long-term decay of the seed bank). *Dampiera fusca* germinates *en masse*, flowers and apparently sets seed in its first post-fire season, then continues to do so until outcompeted by larger shrubs. This suggests that only very frequent fire events (e.g. <4 years) would be a direct threat. Very frequent fire may also increase habitat erosion and the loss of soil organic matter and nutrients.

Dampiera fusca can survive relatively long fire intervals, as evidenced by the mass germination at the Namadgi site after at least 30 years without fire. It is unknown at what rate the seed bank decays and the fire interval that would maximise germination prior to seed bank decay becoming significant.

Monitoring Program

The ACT Government's Parks, Conservation & Lands service has established a program to track the status of the Namadgi population to determine appropriate management strategies at this site. Monitoring commenced in 2007 and will be repeated annually.

A quadrat size of 4 m x 4 m is used to address the problem of the often small, patchy nature of *D. fusca* habitat. Even at this relatively small size, quadrat placement is not always easy due to the extent of rock outcrop and, in areas more degraded by rabbit grazing and digging, by the area of bare soil.

The quadrats are placed along north-south, and east-west transects through areas of known habitat. Monitoring within the quadrats occurs in late October when the population is in flower and the majority of *D. fusca* plants are relatively apparent in what can sometimes be dense heath. The number of quadrats and transects was limited by available time and personnel as well as by constraints such as slope, rockiness, and general accessibility of habitat. The initial sample comprised five quadrats ranging across the different

Dampiera fusca *(left) growing between granite boulders in Namadgi National Park (right). Photos: Roger Farrow*

aspects, vegetation types, and elevations available. This is a minimal but probably adequate sample within the survey's constraints. Ideally, comparisons with populations outside the ACT will be able to be made, though neither NSW nor Victorian authorities have yet indicated an ability to commence a comparable monitoring program.

In each quadrat, the number of *D. fusca* plants is counted along with an estimate of foliage projection cover using standard Braun-Blanquet classes. Foliage projection cover is also recorded for all other vascular plant species. An estimate of the average height and range of heights for all vegetation in each quadrat is recorded, as is the area of rock outcrop and the area of bare soil. The vegetation structure is noted, along with the slope and aspect. Any disturbance is recorded, for example, grazing by rabbits and/or native herbivores such as wombats.

The corners of each quadrat and the start and finish of each transect were permanently marked using a mix of tent pegs and spray-painted dots on rock surfaces. The tent peg in the northeast corner of the quadrat was used as a mount for a metal tag that identifies the quadrat number. The location of each site was also recorded using a differential global positioning system, and each quadrat, transect, and their environs was photographed in a repeatable manner for visual comparison. Annual monitoring will re-sample the same quadrats.

Use of Monitoring Data

The data described above will be used for general monitoring of *D. fusca* and its habitat. In particular, it will be useful in testing the theory that its plants are rapidly outcompeted during post-fire regeneration and that this is a major factor in the species being seen to decline dramatically in abundance after its initial post-fire profusion. It will also be used in combination with weather and climate data to examine potential impacts of drought and current levels of climate change. Observations may also be useful in monitoring the effects of proposed measures intended to control a significant rabbit infestation in and near areas of *D. fusca* habitat in Namadgi National Park.

Acknowledgements

Funding for this research was provided by a Commonwealth Government Envirofund Grant to ACT Parks, Conservation & Lands. The research was overseen by Dr Margaret Kitchin, who along with PC&L staff, assisted with the first application of the monitoring method. Those interested in the results of the *D. fusca* monitoring program in the ACT can contact Dr Kitchin on Margaret.Kitchin@act.gov.au.

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Direct and indirect impacts of fire on the endangered plant *Epacris hamiltonii* at Neates Glen, Blue Mountains

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Introduction

On 20 March 2007 we visited the Neates Glen (Blue Mountains, NSW) population of *Epacris hamiltonii*. The 1994-1996 survey of this site by one of us (Margaret Turton) established that this population consisted of more than 50 mature plants. These straggly, brittle-branched woody shrubs rising to one metre in height can spread for two metres or more.

It had previously been assumed that the Neates Glen population had not been burnt in the Blackheath Glen Fire in December 2002, giving this population the status of being the largest unburnt population. Fire records show that a fire occurred in the area in 1952 (Cohn 1993), however the extent of that fire and whether it burnt *E. hamiltonii* populations are unknown. The extensive fires that burnt in this area in 1994 did not impact this population thanks to quick action by National Parks and Wildlife Service staff who implemented a rakehoe line in the path of an implemented back burn, as well as arranging for helicopter water bombing of the adjacent area.

Observations

Epacris hamiltonii plants

All the large, established above-ground *E. hamiltonii* plant material that had existed at Neates Glen prior to the 2002 fire appears to have perished in that fire. The status of the root systems of the previously well-established shrubs was not examined. Unlike other sites (upper Greaves Creek), where a large percentage of burnt plants have been recorded as re-sprouting, no growth was observed that could be easily attributed to re-sprouting from root-stock. This challenges the previous suggestion that plants routinely respond to fire by re-sprouting from a subsoil root-stock. It is likely that fire intensity determines the extent of root stock survival and the potential for re-sprouting.

Epacris hamiltonii *in flower at Neates Glen, 1998. Photo: Margaret Turton*

Numerous seedlings were observed below the locations of some of the pre-2002 shrubs. No flowering or fruiting was observed on these seedlings in 2007. The width of the population appears to have shrunk away from its former eastern limit, possibly by some 10 metres, and the vertical extent of the population is currently five metres lower than previously observed.

Burnt wire pig-tail stakes with code-embossed metal tags that had previously marked large established plants were found in a tight group, of about a 30 centimetre radius, on one of the upper benches. However no living *E. hamiltonii* plants were found within an approximate three metre radius.

Site conditions

Canopy cover was significantly reduced by the 2002 fire compared with that previously provided by dense-foliaged rainforest taxa rising from the creek bed and by more sparsely foliaged eucalypts on the sloping ridges and cliff lines above the site, on both sides of the creek. The resulting increased exposure to sun is expected to have significantly increased light levels and temperatures and decreased humidity at the site. The increased exposure to wind is also expected to have increased aridity and mechanical buffeting. Overall loss of tree canopy protection is also expected to have increased maximum and minimum temperature exposure.

There is evidence of site disturbance by tree-fall and rock-fall. A portion of the slope below the site has slumped due to the removal of vegetation by the fire. In addition, the hydrology of the site appears to have been significantly affected by the current drought. The latter, in combination with the increased solar radiation, has impacted on both soil moisture levels and the amount of seepage from the cliff face. Fronds of the King Fern (*Todea barbara*) and seedlings of *E. hamiltonii* exhibited excessively dry and dead foliage over unusually large portions of most of these plants.

The current canopy cover at the site does not exceed two metres in height. Post-fire re-growth of King Ferns and re-sprouting branches on burnt Black Wattle (*Callicoma serratifolia*) saplings form the current upper canopy across an estimated 30% of the site. Seedlings of *E. hamiltonii*, ranging in height from around 2-40 cm, cover an estimated 5-10% of the site, which is significantly decreased from previous years, when *E. hamiltonii* was the dominant species. Exposed sandstone and damp, skeletal moss beds, with the occasional sundew (*Drosera binata*), fern (*Blechnum watsii*) or shrub (*Baeckea linifolia*) account for much of the site cover. Below the site, as the slope flattens out, the fern *Blechnum nudum* forms a thick groundcover from which rainforest tree species emerge.

Conclusions

The severe alteration in site conditions resulting directly and indirectly from the 2002 fire, combined with the prolonged drought, appear to have severely impacted the regeneration potential of *E. hamiltonii* at the Neates Glen site. Fronds of the King Fern now constitute a greater canopy cover than previously observed and may diminish the potential for long-term success of the *E. hamiltonii* seedlings.

There are now no known unburnt sites containing mature plants of *E. hamiltonii*. Plants have been previously observed (M.Turton unpublished data, 2004) to take a minimum of eight years to set their first fruit. With the Blue Mountains regional fire frequency standing at 7-10 years or less, the likelihood of any of the known *E. hamiltonii* populations attaining the maturity observed at Lower Greaves Creek prior to 2002 seems low.

Burnt Epacris hamiltonii *site at Greaves Creek, 2002. Photo: Margaret Turton*

Recommendations

Our preliminary observations from a single site visit to the Neates Glen population of *E. hamiltonii* suggest the need for a reassessment of the species' current recovery plan (NSW National Parks and Wildlife Service 2001). We recommend that:

- an *ex-situ* population be established to mitigate further fire-related or other loss of habitat;
- the planned management of this taxon be reviewed in light of the loss of all known mature plants;
- the Lower Greaves Creek site be further studied to record the current ecological state of the population; and
- as a matter of urgency, that fire management practices recognise this species as a high priority. This includes considering it during any fire event within its habitat and taking all necessary precautions to exclude fire from the location of any known populations for a minimum of 15 years.

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Plant conservation on a remote oceanic island: the case of Norfolk Island

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Introduction

Norfolk Island is a remote subtropical island, located about 1,500 kilometres to the east of Australia. Along with several islands nearby, the Norfolk Island Group is a self-governing Australian territory. There are three main islands: Norfolk (3,455 ha), Phillip (190 ha) and Nepean (10 ha). The islands have been settled by Europeans for 220 years, following the establishment of a convict settlement soon after Sydney in 1788. By the mid 19th Century, most of Norfolk Island had been cleared to provide food for the convict settlement and Phillip Island was well on the way to being denuded of its vegetation cover by introduced mammals, including pigs, goats and rabbits. Consequently, there are now many threatened plants in the Norfolk Island Group and their conservation is an ongoing challenge.

Several treatments of the Norfolk Island Group flora have been produced, the most recent and the most comprehensive by Green (1994). Since then, further taxonomic changes have been made and species added to the island list (e.g. de Lange *et al*. 2005; Mills 2007). The flora of the island now stands at 181 indigenous and 363 introduced species. Of the indigenous species, 43 (or 24%) are regarded as endemic. The plant communities on the island, reflecting the original vegetation, are subtropical rainforest, coastal *Sporobolus virginicus* grassland, *Cyperus lucidus* sedgeland and, most limited of all, a sandy beach grassland/herbland.

Threatened Species

As an Australian territory, species identified as threatened on Norfolk Island are listed on the schedules to the *Environment Protection and Biodiversity Conservation Act 1999* (Australia) (EPBC Act). Threat categories relevant to the Norfolk Island listed plants are ‘critically endangered’, ‘endangered’ and ‘vulnerable’. All threatened species are listed in Table 1, along with two extinct species that have not been listed, even though there is provision for such a listing under the EPBC Act.

Of the 46 listed species, 33 (or 72%) are endemic to the island group, representing 77% of the endemic species.

Almost all of the listed species occur within the Norfolk Island National Park, with some important occurrences on public reserves and private land. There have been no recent extinctions; in fact several species have greatly increased in number or reappeared from assumed extinction on Phillip Island since the eradication of rabbits there in the 1980s.

Except for two species, the listed threatened species are relatively secure, partly due to their propagation and planting over the past 20 years. The two species of most urgent attention are the endemics *Wikstroemia australis* and *Euphorbia norfolkiana*. Both species have declined in recent decades, and although in cultivation both on and off Norfolk Island, their wild populations have reached critically low numbers. The reason for the declining populations is unclear, but may be due to soil nutrient changes related to the extirpation of large numbers of breeding seabirds from the forests many years ago. *Achyranthes margaretarum*, represented by a handful of wild plants on Phillip Island, is being propagated and is secure for the time being.

The endangered shrub Coprosma baueri *growing with Phormium tenax on the cliffs of Phillip Island. Photo: Kevin Mills*

Conservation Challenges

The successful conservation of the Norfolk Island Group flora, most particularly the listed threatened species, is challenging for several reasons. The island group is remote, there is a small human population, environmental degradation is high in some places (particularly on Phillip Island) and pests and weeds are ubiquitous. Despite these challenges, the island community along with the managers of the national park have had considerable success in expanding populations of most of the listed species. Key activities include eradication of rabbits from Phillip Island, propagation of most of the threatened species and their re-introduction to many parts of the islands, systematic weed removal from the Norfolk Island section of the national park and localised weeding and planting within some public reserves by the Norfolk Island Administration. Also of note is the work being undertaken to preserve the island's plants and animals by the Norfolk community and individual landowners.

The greatest challenge facing the conservation of the threatened plants of the Norfolk Island Group is the limitations on resources that are available in such a small community. The enthusiasm for protecting the islands' plants by the local community cannot overcome the problem of the limitations on labour, materials and funding that are exacerbated by the isolation of the islands. Thanks to the efforts of the island community and the national park management team, no recent extinctions have occurred. At least two species are in a critical situation and there is still much work to be done.

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Table 1. Endemic and threatened plant taxa on the Norfolk Island Group

Plant Group/Species (Common Name)	Endemic[1]	Threatened[2]
Ferns		
Asplenium dimorphum (Twofrond Fern)	En	-
Blechnum norfolkianum (Norfolk Island Water Fern)	-	E
Crepidomanes endlicherianum (Middle Filmy Fern)	-	
Cyathea australis subsp. *norfolkensis* (Rough Tree Fern)	En	-
Cyathea brownii (Norfolk Island Tree Fern)	En	-
Hypolepis dicksonioides (Ground Fern)	-	V
Lastreopsis calantha (Shieldfern)	En	E
Marattia salicina (King Fern)	-	E
Pteris kingiana (King's Brakefern)	En	E
Pteris zahlbruckneriana (Netted Brakefern)	En	E
Tmesipteris norfolkensis (Hanging Forkfern)	En	V
Trees		
Achyranthes arborescens (Soft Wood)	En	CE
Araucaria heterophylla (Norfolk Island Pine)	En	-
Boehmeria australis subsp. *australis* (Nettletree)	En	CE
Cordyline obtecta (Ti Tree)	-	V
Dysoxylum bijugum (Sharkwood)	-	V
Melicope littoralis (Shade Tree)	En	V
Melicytus latifolius (Norfolk Island Mahoe)	En	CE
Melicytus ramiflorus subsp. *oblongifolius* (Whiteywood)	En	V
Meryta angustifolia (Narrow-leaved Meryta)	En	V
Meryta latifolia (Broad-leaved Meryta)	En	CE
Myoporum obscurum (Popwood)	En	CE
Myrsine ralstoniae (Beech)	En	V
Pennantia endlicheri (Pennantia)	En	E
Pittosporum bracteolatum (Oleander)	En	V
Pouteria costata (Bastard Ironwood)	-	E
Streblus pendulinus (Siah's Backbone)	-	E
Ungeria floribunda (Bastard Oak)	En	V

Plant Group/Species (Common Name)	Endemic[1]	Threatened[2]
Shrubs		
Abutilon julianae (Norfolk Island Abutilon)	En	CE
Achyranthes margaretarum (Phillip Island Achyranthes)	En	CE
Alyxia gynopogon (Evergreen)	En	-
Coprosma baueri (Coastal Coprosma)	En	E
Coprosma pilosa (Mountain Coprosma)	En	E
Euphorbia norfolkiana (Norfolk Island Euphorbia)	En	CE
Freycinetia baueriana subsp. *baueriana* (Mountain Rush)	En	-
Hibiscus insularis (Phillip Island Hibiscus)	En	CE
Ileostylus micranthus (Mistletoe)	-	V
Solanum bauerianum (Bridal Flower)	-	Extinct[3]
Streblorrhiza speciosa (Phillip Island Glory Pea)	En	Extinct[3]
Wikstroemia australis (Kurrajong)	En	CE
Vines and Creepers		
Calystegia affinis (Bindweed)	-	CE
Capparis nobilis (Devil's Guts)	En	-
Clematis dubia (Norfolk Island Clematis)	En	CE
Melodinus baueri (Big Creeper)	En	-
Muehlenbeckia australis (Shrubby Creeper, Pohuehue)	-	E
Zehneria baueriana (Native Cucumber)	-	E
Forbs		
Dianella intermedia (Dianella)	En	-
Elatostema montanum (Mountain Procris)	En	CE
Euphorbia obliqua (Spurge)	-	V
Korthalsella disticha (Mistletoe)	En	-
Senecio evansianus (Yellow Daisy)	En	E
Senecio hooglandii (Yellow Daisy)	En	V
Senecio australis (Yellow Daisy)	-	V
Grasses		
Elymus multiflorus (Phillip Island Wheatgrass)	-	CE
Sedges/Rushes/Reeds		
Carex neesiana (Norfolk Island Carex)	En	-
Orchids		
Dendrobium brachypus (Short-caned Orchid)	En	E
Dendrobium macropus subsp. *macropus* (Long-caned Orchid)	En	-
Phreatia limenophylax (Norfolk Island Phreatia)	En	CE
Phreatia paleata (Phreatia)	-	E
Taeniophyllum norfolkianum (Minute Orchid)	En	V

1. Endemic to the Norfolk Island Group (En).
2. Listing under the EPBC Act: V – vulnerable; E – endangered; CE – critically endangered.
3. These two presumed extinct species are not listed under the EPBC Act.

Lagoons with islands, Tasmanian Highlands

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The Lagoon of Islands

Lagoon of Islands, an 8.99 km^2 area located on the Tasmanian Central Plateau at 738 m altitude, was once a unique vegetation type of shrubby islands sitting on a floating mat of reeds (Fig. 1). The reed mat was dominated by *Baumea arthrophylla*; one trod gingerly on its interlaced rhizomes. The floating reed sward was progressively colonized by tufted sedges (mainly *Carex appressa*), shrubs (mainly *Leptospermum lanigerum* and *Callistemon viridiflorus*) (Fig. 2) and small *Eucalyptus* trees to form small islands (see Fig. 3A-3C). Eventually the accumulating mass of vegetation depressed the mat, forming a moat around each island (Fig. 3D). Its vegetation, now waterlogged, died and decayed leaving a pool which, presumably, would be reclaimed by the reeds (Fig. 3E-3F).

Lagoon of Islands was unique in that the floating islands' seral process (i.e. the process building them and leading to their destruction) differed conspicuously from the events in the 234 other known cases of such islands (Van Duzer 2004, and pers. comm. 2008). Its uniqueness was bolstered by participation in the process of several plant species endemic to Australia and even to Tasmania, for example *Callistemon viridiflorus*. These unique properties were lost when the lagoon was dammed in 1964 and its floating reed mat and islands destroyed (Tyler 1976).

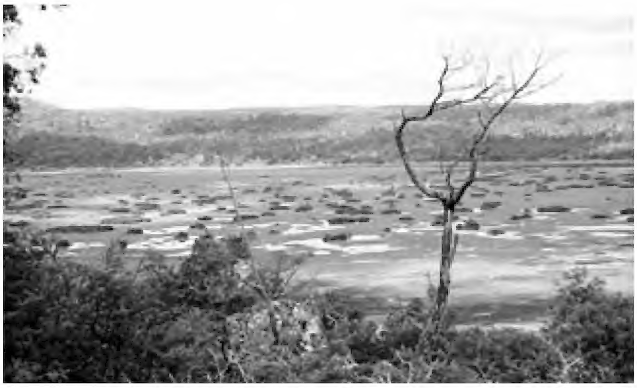
In the 35 years since damming, water quality in the lagoon has deteriorated severely (Maxwell and Tyler 2006). The water levels have periodically been manipulated in attempts to improve the quality of riparian water. One outcome of this was it seemed likely that the aquatic herb *Triglochin procera* would colonise the entire basin (Maxwell and Tyler 2006). In recent years water quality has deteriorated further as remnants of the vegetation decayed. Today Lagoon of Islands is a foul swamp but *Baumea arthrophylla* is recolonising it, presumably from surviving propagules of the original reeds. This raises questions about whether the recolonisation should be allowed to continue, perhaps eventually to restoration of the original ecological state, or manipulated to improve riparian water regardless of vegetational considerations (Maxwell and Tyler 2006).

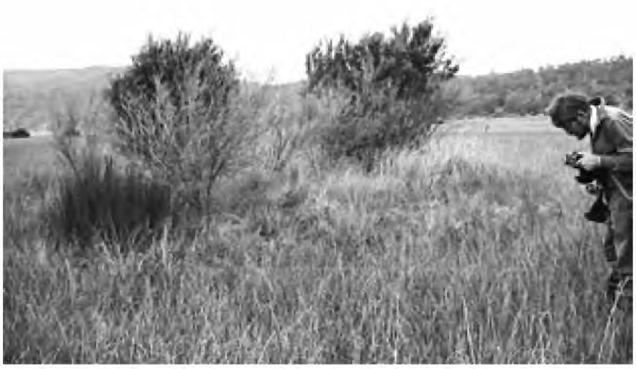
A new Lagoon of Islands?

Whatever the future holds for Lagoon of Islands, another lagoon higher on the Central Plateau (1028 m altitude) bears many resemblances to it. One of us (Tyler) has known of it for 45 years because the similarities are evident from inter-state flights, but the islands' species composition and whether they were floating could not be determined from the air.

In 2005 we briefly visited the lagoon (Fig. 4). It lies 6.6 km north of Lake Sorrell's northern shore, in Lagoon Plain, a tract of heathland dominated by species in the family Restionaceae and Epacridaceae and surrounded by sclerophyll forest. The lagoon is approximately circular, about 278 m in diameter, and with an area of 6.25 ha is considerably smaller than Lagoon of Islands, but has many similarities with it. Because of its resemblance (when seen from the western side) to the original Lagoon of Islands, we call the un-named lagoon 'Companion Lagoon'.

Companion Lagoon had a distinct embankment at its eastern margin, which suggests a wind borne (aeolian) origin. A zone of *Villarsia reniformis* around the lagoon's circumference gave way to a dense, more or





(left to right) Figure 1. Lagoon of Islands from the western shore, 1963. Figure 2. Lagoon of Islands, 1963, showing an island at the formative stage of colonisation of the tufted sedge Carex appressa *by herbaceous plants and woody shrubs. Photos: Peter Tyler*

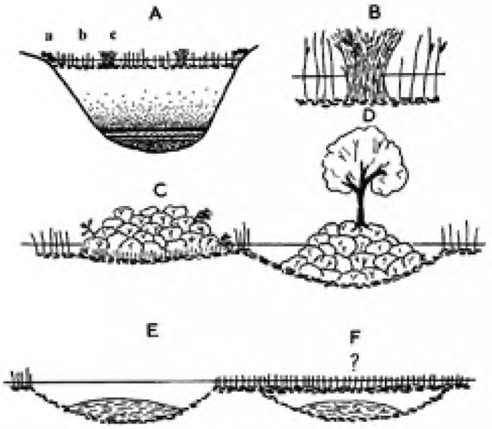


Figure 3. A, diagrammatic cross section of Lagoon of Islands basin: a, Villarsia *zone; b,* Baumea *reeds; c, islands. B-F, representation of seral stages of the genesis and demise of islands (see first paragraph in article for explanation). (Modified from Tyler 1976).*

less continuous reed mat of *Baumea arthropylla* (Fig. 4). It is unknown whether this mat was floating or whether the *Baumea* rhizomes were anchored in the lagoon sediments. The lagoon's topography suggests the latter, as does the presence of shrubs on even small islands, but this was not verified.

Numerous tussocks in various stages of development sprang from the *Baumea* mat, which again bears striking resemblance to the development of islands at the original Lagoon of Islands. Although the sedge *Carex appressa* was the principal tussock former at Lagoon of Islands, the species at Companion Lagoon was not determined. The dominant woody colonisers at both lagoons are *Leptospermum lanigerum* and *Callistemon viridiflorus* (Fig. 5). Other species observed at Companion Lagoon were *Baeckea gunniana* and *Empodisma minus*. A feature of tussock/island building at Companion Lagoon not recorded or remembered for Lagoon of Islands was the occurrence of *Sphagnum* sp. The sedge *Eleocharis sphacelata* was present in a few areas of both lagoons.

Analogue or Homologue?

Lagoon of Islands today is badly degraded, and although recolonisation by *Baumea* is underway (Maxwell and Tyler 2006), the processes that resulted in its unique vegetation type may or may not proceed to the point of full restoration. We therefore regard Companion Lagoon as the 'custodian' of the vegetation type and at least a part of the ecological process.

The strong visual resemblance between the original Lagoon of Islands and Companion Lagoon (compare figures 1 and 4), the similarity of their seral processes of island building and the involvement of many species in common (compare figures 2 and 5), when taken together, strongly suggest that Companion Lagoon is a miniature replica of Lagoon of Islands, built in much the same way, by the same species and the same ecological processes.

Conservation

The area of the Central Plateau in which Companion Lagoon and its surroundings are situated is a designated Conservation Area which should afford protection. What is now desirable is a thorough investigation, especially to obtain a more complete inventory of plant species and to determine whether the reed mat is overarching or is rooted in the bed of the lagoon. These would allow assessment of the degree of homology or analogy between the two, from which appropriate conservation measures may be enacted.

Acknowledgements

We thank David Blüdhorn and Adam Uytendaal for getting us to Companion Lagoon and Alex Buchanan of the Tasmanian Herbarium for making or checking plant identifications.

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(top to bottom) Figure 4. Companion Lagoon from the westerm shore, 2005. Figure 5. Vegetation of Companion Lagoon, showing Baumea *reeds and stages of island formation. Photos: Peter Tyler*

Report from New Zealand Plant Conservation Network

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Council Meeting

A face to face Council meeting was held in Wellington in October. We briefed the meeting on the conference, finances, progress with existing projects (e.g. The Threatened Plant book, Marae based training courses, and digitising botanical society journals), ideas for additional sponsors for the Network, recruitment of new members, and the establishment of the Trust to administer the David Given Scholarship. We also discussed publishing the conference abstracts and material from the conference workshops (which is now imminent), and decided to prepare a business plan for the Network to incorporate member aspirations for it and communicate our business more effectively.

Kids at the Conference

My last report omitted to mention a very exciting, and different, part of our conference: the involvement of more than 80 children from 20 of the Wellington region's Enviroschools who presented their school conservation projects to delegates during one day of the conference. Enviroschools is a charitable trust that provides support and strategic direction for a nation-wide environmental education program. Organised by the NZPCN and Enviroschools to promote plant conservation to the next generation, the forum inspired both the children, who learned more about their native flora by discussing their projects with plant experts, and delegates who were encouraged and inspired by the on-the-ground conservation projects schools carry out. During lunch, awards were given to the children by NZPCN President Ian Spellerberg. I am certain no conference lunch has ever been this action-packed or noisy!

Perils of Web Popularity

The network website was one of the main items we discussed at our council meeting. It is not the content that is the issue; rather it is the hosting of the site and the associated technical problems, including the need to make the site more secure. We have been the target of malicious hackers due to the high number of 'hits' we receive and the number of sites which link to ours. All of this is taking time to resolve and there are associated costs of a not inconsiderable nature.

60th Newsletter Published

Trilepidea, the network's monthly newsletter, has achieved a milestone with its 60th issue. Each month over 500 members receive an electronic copy of *Trilepidea*. The newsletter averages about 6 pages and is made up of member's observations, trip reports, and anecdotes. It communicates name changes, new species, research updates, and much more. The newsletter also promotes botanical trips run by botanical societies regionally. It is useful as a forum for botanical debate as has recently been shown when one member posed the question "where in NZ is the highest diversity of plants?"

Research Roundup

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Book Review

FRUIT
Edible, Inedible, Incredible

Authors: Wolfgang Stuppy and Rob Kesseler
Papadakis Publishers in association with the
Royal Botanic Gardens, Kew, 2008,
305 x 280 mm, 264 pages in full colour.
ISBN 13: 978-1901092-74-5
Price GB£35.00 (c. AU$78.50 as at Dec 2008)
www.papadakis.net

As with the two earlier books in this series (*Pollen–The Hidden Sexuality of Flowers* by Kesseler and Harley, and *Seeds–Time Capsules of Life* by Kesseler and Stuppy), this book is a very high quality publication. It is worthy of placement on the shelves of all botanists, students and public alike, who have an interest in the history, evolution, structure, and role of fruits in the maintenance, resilience and survival of plant species and plant populations.

The text by Wolfgang Stuppy takes the reader through a clear but detailed history and background to fruits and their function and role, starting with an interesting review of what is a fruit, what is a vegetable, when is a fruit a vegetable and vice versa. This interesting and challenging introduction sets the scene for the fascinating descriptions of the many types of fruit and how they develop from all parts of the flower, that even many botanists would not be aware of, or recognise.

Examples of the many types of fruit are described in detail but in a way that is easily understood and provides motivations to re-read. It is made even more interesting by the selection of examples from unique, strange and little-known plants, to well recognised plants, the fruits of which provide much edible food for many indigenous human populations. Examples are sourced from bioregions around the world, making the descriptions of fruits of even more interest to readers from those regions. A number of Australian examples are presented in the text as part of the overview of the many types and forms of fruits, e.g. eucalypts, banksias and cycads.

Many technical botanical terms are used in the text, but these do not detract from the excellent descriptions of the fruits. The terms may be somewhat daunting and confusing to readers without a botanical background, but knowledge of them is not necessary to gain an insight into the fascinating types, shapes and sizes of fruits. The origins or bases for the terms are clearly explained, which emphasizes the need for clear and concise terms in the classification of plants, particularly the classification of fruits.

A very good glossary of botanical terms, each with a precise definition, is appended in the book. This provides for further understanding of the terms and the need for them to classify botanical attributes, which do not always comply with generally accepted conventions of what constitutes a fruit in source, structure and function. This increasingly raises one's curiosity as to the next intriguing example of a fruit, be it large and conspicuous, such as the breadfruit, or small and inconspicuous.

The outstanding text is both informative and inspiring and would widen everyone's knowledge and understanding of what is a fruit, far beyond our general recognition of fruits as being soft, succulent and tasty. While the text focuses on the wide range and forms of fruit, it also provides a fascinating overview of the role of fruits in dispersal of seed by animals, wind, water, rainfall and combinations of these dispersal mechanisms. The equally fascinating history of co-evolution of many plants and animals that benefit from each other by way of food source and seed dispersal, like so much of the book, inspires the reader to read the book, or chapters of it, more than once. The book engenders a sense of need to discover more about fruits, their many forms, shapes and structures and their dispersal mechanisms.

The inspiring text by Wolfgang Stuppy is brought to life by the amazing photographs taken by Rob Kesseler and displayed in the book to show the range of fruits and their external and internal structures. Arguably, photographs of such detail, particularly the stunning cross-section photographs of fruit structures, have never been published before with such clarity and colour, the latter having been artistically added to the monochrome images obtained from electron microscope photography.

Rob Kesseler set out to develop images for this book that not only reflect the subject but extends the creative evolution and interpretation of microscopic plant material from his previous two books. He certainly achieves this through the clarity of his photographs and his skill in colouring them to fully represent subtle chromatic variations, that he states, occur naturally. His photographs are a combination of artistic skill and scientific rigour and if for no other reason, this book should be a reference for all botanists, especially those aspiring to be carpologists, as well as a coffee-table book for those generally interested in fruits, be they edible, inedible or simply incredible.

The book finishes with a short chapter on the *Millenium Seed Bank Project – A fruitful partnership for survival*. The book will provide much support for and understanding of this project, one which we should all be motivated to support by this high quality publication.

The authors and publishers can be justly proud of this book, as would anyone purchasing a copy.

Roger Good, Botanist / Ecologist

Information Resources and Useful Websites

The Pea Key on-line

Roger de Kok and Ed Biffin (coordinators)

The Centre for Plant Biodiversity Research and Australian Biological Resources Study, Canberra, have developed an interactive key to the pea-flowered legumes of Australia (Fabaceae) that can by accessed and used on-line. Like other interactive keys such as *Euclid Eucalypts of Australia* and *Wattle: Acacias of Australia*, the Pea Key is based on the Lucid software. The on-line version provides guidance on how to use the key to identify specimens, as well as background information on Australia's legumes, a detailed glossary of terms used and other information. The web version of the Pea Key can be accessed at <http://www.cpbr.gov.au/cpbr/cd-keys/index.html>.

Australian Fungi and Australian Bryophytes

http://www.anbg.gov.au/fungi/index.html

http://www.anbg.gov.au/bryophyte/index.html

These two web sites from the Australian National Botanic Gardens provide a wealth of information about Australia's fungi and its hornworts, liverworts and mosses. The fungal site includes sections on what a fungus is, types of fungi, dispersal, the mycelium, ecology, mycorrhizas, mycogeography, truffle-like fungi, aboriginal use of fungi and historical fungal studies. The bryophyte site similarly discusses what a bryophyte is, the three groups of bryophytes, life cycles, reproduction and dispersal, ecology, classification and identification, bryogeography and the history of bryology in Australia. It also has case studies that include more detailed information about specific topics. Both sites are well illustrated and have links to references and a wide range of other websites on fungi and mosses.

Why dryandras have changed their name

http://florabase.calm.wa.gov.au/articles/dryandra-banksia/

Not all ANPC members may be aware that plants formerly in the genus *Dryandra* are now all included in the genus *Banksia*, for example *Dryandra sessilis* is now called *Banksia sessilis*, while *Dryandra ferruginea* is now called *Banksia rufa*. The article at this website, from the Western Australian Herbarium, explains as simply as possible why this name change has become necessary. If you sometimes curse taxonomists for making your life more difficult because you have to re-learn the scientific names of plants you know well, the article is definitely worth reading! You can get a quick checklist of the new names for dryandras through a search on the Australian Plant Census database (see above) using <Dryandra%>.

Australian Plant Census

http://www.anbg.gov.au/chah/apc/

The Council of Heads of Australasian Herbaria (CHAH) is gradually working its way through the Australian vascular flora, both native and introduced, to provide an agreed list of currently accepted names for each taxon. As at December 2008, 254 families had been completed. A table accessible from the website ('list of families') shows which families have been covered and whether they have been incorporated into the on-line, searchable Australian Plant Census database.

The introduced flora of Australia and its weed status

R.P. Randall

CRC for Australian Weed Management and Department of Agriculture and Food, WA, 2007

This publication is a resource for everyone who cares about the Australian environment and wishes to ensure that plants chosen for revegetation projects, landscaping and gardens are not likely to become weedy and a threat to our bushland or agriculture. It contains a checklist of 29,430 species, including 606 Australian species that have naturalised (i.e. reproduced without human intervention) outside their native range, and provides information on the weedy status of each species in Australia and worldwide. A pdf version of the publication can be downloaded from <www.weedscrc.org.au/weed_management/intro_flora.html>, while a searchable on-line database of the checklist can be accessed at <http://weeds.cbit.uq.edu.au/>.

Serrated Tussock: national best practice management manual

R. Osmond, M. Veebeek, D.A. McLaren, M. Michelmore, B. Wicks, C.J. Grech and P. Fullerton

Department of Primary Industries, Victoria, 2008

This book outlines current management and control options for Serrated Tussock (*Nasella trichotoma*) in Australia. Its information has been sourced from published material, research, reviews by technical experts and the experiences of many individuals and organisations managing the weed here. It provides a profile of the species, discusses integrated weed management, how to develop a control program, relevant control methods and management practices, and includes ten case studies. Copies of the manual can be downloaded from <http://www.weeds.org.au/WoNS/serratedtussock/>.

Information Resources and Useful Websites (cont.)

Native plant species at risk from Bitou Bush invasion – a field guide for NSW

Mark A. Hamilton, Marion A. Winkler and Paul O. Downey

Department of Environment and Climate Change (NSW), 2008

This guide aims to assist land managers, contractors and volunteer/community groups working on Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) control or restoring sites that have been invaded by it. The book describes plant species, plant populations and ecological communities at risk from the weed, and includes photographs of each, symbols to help with fast identification, and written description to help confirm their identity. Copies of the guide can be downloaded from <http://www.environment.nsw.gov.au/bitouTAP/IDguide.htm>.

Habitat management guide – Riparian: weed management in riparian areas, south-eastern Australia

F.J. Ede and T.D. Hunt

CRC for Australian Weed Management, Adelaide, 2008

Riparian corridors are particularly susceptible to weed invasion, often by multiple weed species. This guide provides background information about riparian areas and weed species typically found in riparian areas in south-eastern Australia (particularly Victoria), and highlights the central role played by water flow (especially flooding) in shaping riparian areas and management of their weeds. It describes the general principles for, and steps required to develop, an effective weed management program. Copies of the guide can be downloaded from <http://www.weedscrc.org.au/documents/hmg_riparian.pdf>.

Habitat management guide – Rainforests: ecological principles for the strategic management of weeds in rainforest habitats

H. Murphy

CRC for Australian Weed Management, Adelaide, 2008

Rainforest weeds can occur in relatively intact rainforest as well as around the edges of rainforest patches and in highly disturbed areas within them. This guide focuses on the ecological processes that govern weed invasion in rainforest habitats and the ecological principles for managing them strategically with the aim of minimising their introduction and spread. Copies of the guide can be downloaded from <http://www.weedscrc.org.au/documents/CRC_HMG_Rainforests_v6a.pdf>.

OzCoasts

http://www.ozcoasts.org.au/index.jsp

This web site, which provides comprehensive information about Australia's coast, including its estuaries and coastal waterways, was developed by over 100 coastal scientists. The information on the site helps to generate a better understanding of coastal environments, the complex processes that occur in them, the potential environmental health issues and how to recognise and deal with them. The site includes an Environmental Management module to help users to continually improve coastal natural resource management.

Conferences and Workshops

Charles Darwin Symposium

26 February 2009
National Museum of Australia

Free. Bookings: 02-6208 5021

Futher information: http://www.nma.gov.au/events/darwin_symposium/

The Fenner Conference on the Environment The art & science of good environmental decision making

10-12 March, 2009
Shine Science Centre, Canberra, ACT

Australia invests billions of dollars on restoring its landscapes, protecting biodiversity and managing invading weeds and pests. This conference will examine issues related to the environmental returns on this investment, the transparency, accountability and defensibility of environmental decisions, how to make decisions in the face of growing uncertainty, and how to do better. The discussions will be framed around the themes of environmental decision-making, prioritisation, adaptive management, monitoring design for biodiversity conservation, monitoring design for soil and water quality, and tools and techniques for environmental decision-making.

Further information: http://www.conferenceplus.com.au/fennerconf/2009/

CSIRO GREENHOUSE 2009 Climate Change and Resources

23-26 March 2009
Burswood Convention Centre, Perth, WA

Climate change is the environmental issue of our times. Scientific understanding is advancing at a remarkable rate, with new information emerging rapidly about the likely impacts of climate change, the options to adapt to these changes, and new approaches to controlling greenhouse emissions. This conference is the latest in the 'GREENHOUSE' series, following the highly-successful events in 2007 in Sydney, and 2005 in Melbourne. The GREENHOUSE 2009 program will cover a range of issues, from the latest Australian and international climate change science to examples of how industry and government are tackling climate change.

Further information: http://www.greenhouse2009.com/

The International Association for Ecology (INTECOL) 10th International Congress Ecology in a Changing Climate: Two Hemispheres – One Globe

16-21 August 2009
Brisbane, Qld

Hosted by The Ecological Society of Australia and The New Zealand Ecological Society, conference participants will explore how global climate change has impacted, and will further impact, ecosystems and their vital services to human communities. They will examine unique features of ecosystems in the southern and northern hemispheres but look for common elements in a search for solutions to this looming problem. Symposia will represent all scales of ecology from individual organisms to landscapes, and report on a diversity of ecosystems – from marine to freshwater aquatic systems, and from arid to rainforest and polar to tropical terrestrial ecosystems.

Further information: http://www.intecol10.org

Society for Ecological Restoration International (SERI) 19th World Conference on Ecological Restoration Making Change in a Changing World

23-27 August 2009
Perth, WA

SERI world conferences aim to provide a critical platform to assist in defining the principles of restoration, understanding goals and milestones, debating what ecosystem functions to measure and closing the gap between the science of restoration ecology and the practice of ecological restoration.

Themes to be included in the 19th conference include

- restoration ecology in a changing world
- social and cultural aspects of restoration
- restoration at the landscape scale
- ecological restoration of ecosystems
- ecological restoration of disturbed sites
- ecological restoration within urban areas
- ecological restoration of threatened species, populations and habitats
- management and technical aspects
- disturbance ecology and management.

Further information: http://www.seri2009.com.au/pages/home.html

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SECOND NATIONAL FORUM

APRIL/MAY 2009 – SECOND NOTICE

Minding our own biodiversity: CONSERVATION ON PRIVATE LAND

Thursday 30 April – Friday 1 May 2009

Venue: Halls Gap, The Grampians, Victoria

Don't miss this timely forum!

The ANPC's second national forum will focus on conservation outside the formal reserve system. It will highlight the people and places involved and investigate the incentives and support available.

Private land is the key to linking biodiversity conservation across the landscape

This is your opportunity to participate, learn, contribute, debate and move this essential component of biodiversity conservation forward.

The forum will include six sessions:

- People, passion and place – connecting for conservation
- The big picture: large-scale bio-link projects
- Regional and local projects (Trusts, NGOs, Conservation Management Networks)
- Multiple benefits of working with native vegetation
- The context in which we work (institutional and legislative frameworks)
- Support and incentives for landholders (facilitated discussion)

Sessions will include presentations from landholders and organisations. The forum will conclude with a ½ day field visit to local sites.

Registration fee (includes morning & afternoon tea, lunch, field costs & GST)

- Full registration: $240
- ANPC member: $210

There will be an optional forum dinner on Thursday night (details and cost to be advised).
Guest speaker: Andrew Campbell (Triple Helix Consulting)

Program & registration form: on the ANPC website from late January 2009.

Accommodation: participants will be responsible for booking accommodation in Halls Gap. Accommodation information will be provided on the ANPC website.

http://www.anpc.asn.au/conferences.html
phone 02-6250 9509

Australian Government
Land & Water Australia

Wimmera Catchment Management Authority

Glenelg Hopkins CMA

State Government Victoria Department of Sustainability and Environment

Greening Australia

Photos: (main) Open woodland on private land with The Grampians behind. Photo by Paul Gibson Roy. (top, l-r) A buloke mistletoe (*Amyema linophylla*), listed as Vulnerable in Victoria; in the Wimmera plains. Photo by Steffen Schultz. Landholders at a seed production field day at Hamilton. Photo by Paul Gibson Roy. (bottom, l-r) Halls Gap valley floor; revegetation site on Anthony and Melissa Mair's property. Photo by Phil Alison. Native apricot (*Pittosporum*), a typical plant of Wimmera's woodlands communities. Photo by Steffen Schultz.

Australasian Plant Conservation
BULLETIN OF THE AUSTRALIAN NETWORK FOR PLANT CONSERVATION INC

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